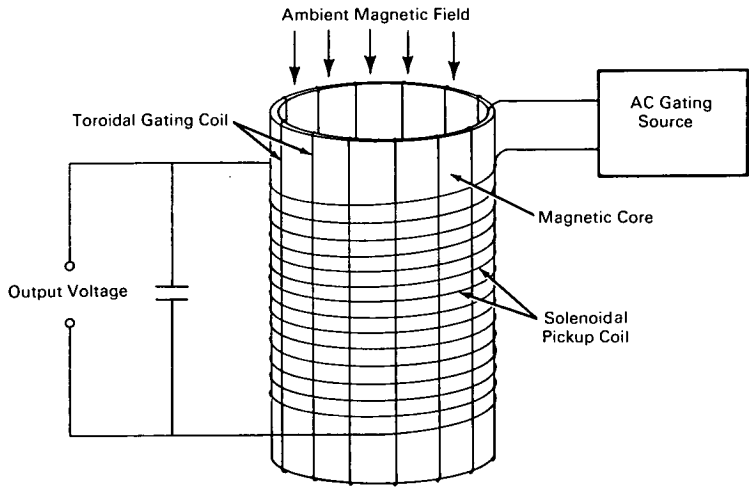
NASA TECH BRIEF

Improved Magnetometer Uses Toroidal Gating Coil



The problem: Providing a magnetometer with improved accuracy and sensitivity. Interaction of the magnetic flux produced by the magnetometer gating source with the ambient magnetic field (e.g., the earth's magnetic field) being measured by the magnetometer can introduce noise or error in the pickup coil (unless very careful filtering is provided), resulting in an inaccurate measurement. Gating flux leakage may also disturb the ambient field sufficiently to introduce error in other nearby magnetometers or electronic circuits.

The solution: A magnetometer employing a cylindrical, high-permeability magnetic core, with a toroidal gating coil winding and a solenoidal pickup coil winding.

How it's done: The toroidal gating coil is uniformly wound so that each turn is parallel to the longitudinal axis of the magnetic core. With this manner of winding, the effective direction of the magnetic flux generated by the current in the gating coil will be perpendicular to the core axis, thereby minimizing axial flux leakage and disturbance of the ambient magnetic field. Since the toroidal winding completely surrounds the magnetic core, the gating flux constitutes a circular magnetizing field that is effectively confined to the core. The solenoidal pickup coil is comprised of a relatively large number of turns which are uniformly wound so as to be concentric with the axis of the core. Gating flux is thus effectively decoupled from the pickup coil windings, both because of the relative perpendicularity of the toroidal and pickup coil windings and the confinement of the gating flux in the core. Both sets of windings are electrically insulated from the core.

In making a measurement, the core is positioned so that its axis is parallel to the ambient magnetic field. The ac gating current generates an alternating magnetic field which cyclically desaturates and saturates

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the magnetic core, thereby varying its permeability from its original high value to unity. Since saturation and desaturation occur twice for every cycle of gating current, the ambient magnetic flux within the core and the resultant output voltage from the toroidal coil cycle at twice the frequency of the gating current. The capacitor across the solenoidal coil makes the pickup circuit parallel-resonant at the output voltage frequency. The output voltage is proportional to the rate of change of the gated ambient flux. A calibrated voltmeter connected to the output leads indicates the magnitude of the ambient magnetic field.

Notes:

1. Flux interaction can be further reduced by electrostatically shielding the pickup coil from the gating coil.
2. An early model of this magnetometer had a sensitivity approximately one hundred times that of standard flux gate magnetometers of comparable physical size.
3. The magnetometer may be used as a magnetic amplifier for low-level electrical signals which have been converted to low-level magnetic fields.
4. The principle of this magnetometer should have application in navigation devices.
5. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10103

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use are available. Inquiries concerning license rights should be made to NASA, Code AGP, Washington, D.C., 20546.

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